Parameters used to assess the efforts to control paratuberculosis in Denmark

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4. Parameters used to assess the efforts to control paratuberculosis in Denmark

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4.1. Abstract

Key parameters used to assess the efforts to control *Mycobacterium avium* subsp. *paratuberculosis* (MAP) in dairy cattle in Denmark are summarised. These parameters are discussed at national, programme and herd level. The primary aim of the control programme is to reduce the prevalence of MAP infections nationally. Therefore, monitoring of the prevalence is important. Many farmers are thought to be only partly active in MAP transmission management. They are not expected to control or eradicate MAP from their herds and therefore do not contribute to the reduction of MAP nationally. Hence, "active participation" is considered another key parameter. Tools and information to motivate farmers to participate are continuously being developed. Lastly, farmers in the programme expect to be certified "free of paratuberculosis" within 4-10 years. Hence, a certification module must be added to the existing control programme.

4.2. Introduction

A voluntary control programme on bovine paratuberculosis was initiated in Denmark in March 2006 (Nielsen et al., 2007). The scheme is administrated by the Danish Cattle Federation (DCF), and has these objectives:

1) to provide tools to farmers to control paratuberculosis, and
2) to reduce the overall prevalence of paratuberculosis in Denmark.

There are currently no options for certification of herds or animals free of MAP infection, and "free of paratuberculosis" at both cow and herd level is considered not to exist.

The target condition in the programme is all animals infected with *Mycobacterium avium* subsp. *paratuberculosis* (MAP), because all infected animals are at risk of becoming infectious and affected by MAP, resulting in long-term and short term losses to farmers. The herd-level prevalence has been estimated at approximately 80-85%, and the animal-level prevalence at 20-30%, although these estimates are subject to a great degree of uncertainty.

The programme is run as a risk-based control programme where frequent testing (4 herd screenings per year) is carried out to divide animals into high-risk and low-risk groups (Nielsen, 2009). Animals are tested using an ELISA for detection of MAP specific antibodies in milk. Samples are obtained via the milk recording scheme. Farmers should establish management procedures to reduce MAP transmission from high-risk animals. Low-risk animals require less attention with regard to transmission of MAP. Specific animals ("Red cows", i.e. cows with repeated positive test-results) are recommended to be slaughtered prior to next calving.

Vaccination against MAP infections has been prohibited in Denmark since January 1, 2008. Prior to this, vaccination could occur with permission from the veterinary authorities. Approximately 24 existing farms hold permission to vaccinate and can therefore host vaccinated animals. All these herds have been or are participants in the programme, and 13 of the herds have false-positive results due to vaccination.

This paper describes parameters that are considered important to meet the objectives of the Danish control programme on paratuberculosis.

4.3. Reasons for participation

Reasons for not participating in the programme are only partly known. Among 167 farmers not participating in the programme on the island Funen, 100 were contacted in a telephone inter-

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view in February 2009. Only 49 wished to participate in the interview, and the 51 non-participants typically stated that they did not have paratuberculosis on their farm and therefore considered it pointless to participate in an interview regarding lack of participation in a paratuberculosis control scheme.

Among the 49 responders, 5 only gave a partial response. The responders expressed:

- 7/44: test costs are too high;
- 13/44: too many changes in housing facilities are required;
- 4/44: insufficient advice on how to control MAP infections had been received;
- 24/44 were awaiting experiences of other farmers in the control programme;
- 8/44 expected to leave cattle farming within 1-5 years;
- 24/44 thought the financial gain in controlling MAP was too small;
- 23/44 considered their herd to be "free of paratuberculosis".

Among the farmers participating in the control programme, the predominating reason for participation is that control of *Mycobacterium avium* subsp. *paratuberculosis* (MAP) infections improve animal health and avoids production losses. Only 45% believe they have actually experienced production losses related to MAP infections (Table 1). Certification "free of MAP" within 4-10 years is also desired by the majority.

Table 1: Summary of reasons for participation in the Danish control programme on paratuberculosis based on questionnaire sent to 1170 participants of the programme in December 2008-March 2009. A total of 1013 (87%) responded to the questionnaire. Each farmer could provide multiple reasons for participation

Reasons for participation in programme	Yes	(%)	No or do not know
Herd certification within 1-3 years	245	(24%)	768
Herd certification within 4-10 years (or 1-3 years)	796	(79%)	217
Herd certification to provide animals for sale	488	(48%)	525
Control following production losses in the herd	454	(45%)	559
Control to avoid production losses	822	(81%)	191
Control to improve animal health	882	(87%)	131
Control to improve food safety	553	(55%)	460

4.4. Parameters of importance

A number of parameters for measuring the efforts against MAP infections are being considered in the administration of the programme. DCF has an obligation to provide farmers, if possible, with cost-effective means to manage relevant veterinary issues. MAP infections are costly in the view of the DCF both in short and long term perspectives. Because MAP is widespread, it is for the individual farmer to decide if she/he will take the risk of not controlling MAP infections through the scheme recommended by the DCF. However, if the prevalence is low and eradication from the country is deemed feasible, DCF could decide to take steps that would effectively make a programme compulsory.

"Successful management of MAP infections" can therefore differ at different levels and in different populations: the national herd, the herds in the programme and within the individual herd.

National level

A. Participants

The ultimate aim is to include all herds with MAP infected animals in the control programme, and all herds in a future certification programme. Non-participating herds are a potential source

of MAP, because their status is unknown and they should therefore be included in the future, and in a potential eradication programme.

However, only herds with established management procedures to reduce transmission from high-risk animals should be included in the control programme. Farmers that do not have such procedures implemented will not experience success, and may reflect poorly on the programme and may also blame the tools and recommendations provided by the programme.

There are currently (June, 2009) 1255 dairy herds enrolled in the Danish control programme on bovine paratuberculosis. The national herd consists of approximately 4294 dairy herds and 500 000 cows (average herd size = 116 cows). The average herd in the programme is approximately 160 cows. Approximately 29% of all herds and 40% of all cows are enrolled in the programme.

To enrol farmers, there has been two "recruitment periods": February-March 2006 and September-December 2006. Information material was distributed to all farmers to actively recruit farmers in those two periods only. Since its inception in March 2006, 256 herds have left the programme, with 103 (40%) citing cessation of milk production.

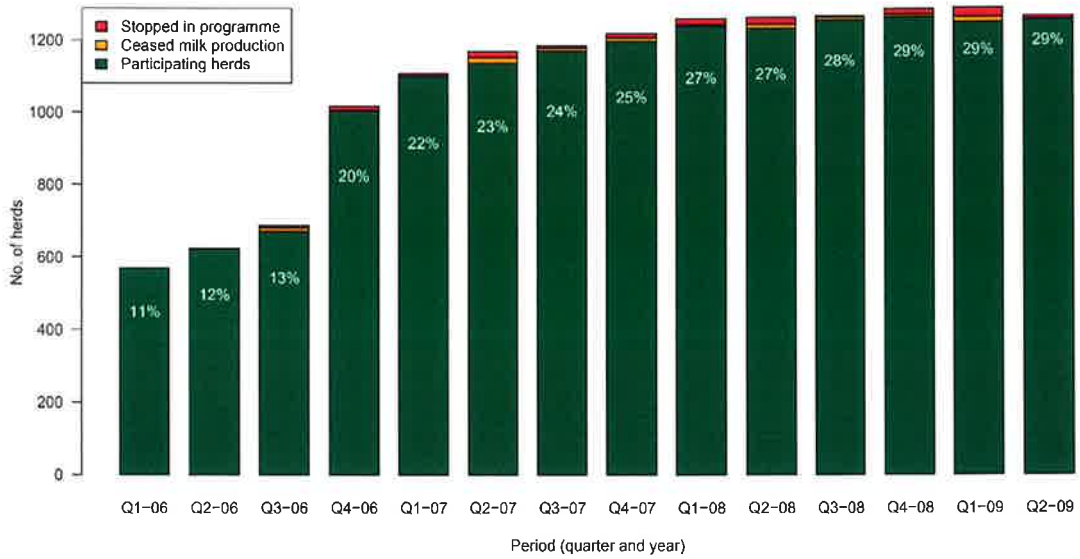

Figure 1. Number of participants in the Danish control programme of bovine paratuberculosis. The percentages given are the proportion of herds in the programme among all dairy herds in Denmark.

B. Communication.

Communication with participants in the programme and non-participants is considered vital. The aim is to provide communication tools for

- Motivation of continued efforts to control MAP;
- Efficient risk-based management of MAP infected animals;
- Monitoring of the development of MAP in the programme;

and to provide up-to-date information that clarifies uncertainties regarding specific problems experienced by farmers and herd health advisors.

Communication of management strategies, test results and other information found to be vital to the programme is done via the DCF. An advisory board consisting of herd health advisors, programme managers and scientists address issues that are of concern to farmers.

Test reports developed by the DCF should be the standard for communication of test-results. Newsletters are published 6 times per year and issued to farmers and herd health advisors. Continuous close contact through e-mail with herd health advisors is used to be "present" in the "field" work related to the control programme.

C. New options and opportunities.

There is continuous focus on developing new options and features that will keep farmers motivated. Establishment of a certification module in the paratuberculosis programme is a high priority, partly to meet the reasons for participation (Table 1) and to attract new participants who believe they do not have MAP in their herd. So far, no herds are considered "free of MAP". However, options for gradually increasing the probability of freedom is being investigated in order to a) keep farmers motivated for staying in the programme; b) attract new participants; and c) facilitate purchase of animals with a low risk of being infected with MAP.

Recently, a "reduced sampling scheme" for herds with 2 years in the programme has been launched. The objective is to reduce testing costs without concurrently compromising the risk-based management scheme. All cows are automatically identified at the laboratory if they do not have a "valid" test-result. Under the reduced scheme, cows fulfilling specific criteria can be skipped for a certain period of time.

Programme level

I. Development in the apparent prevalence

A specific aim of the programme is to reduce the prevalence of MAP infections in Denmark. Therefore, a key parameter is monitoring the prevalence in participating herds to determine if the prevalence is actually reduced. Estimation of the true prevalence is a challenge because of inaccurate diagnostic tests and because culling of test-positive animals can greatly affect the test prevalence without a simultaneous drop in the true prevalence.

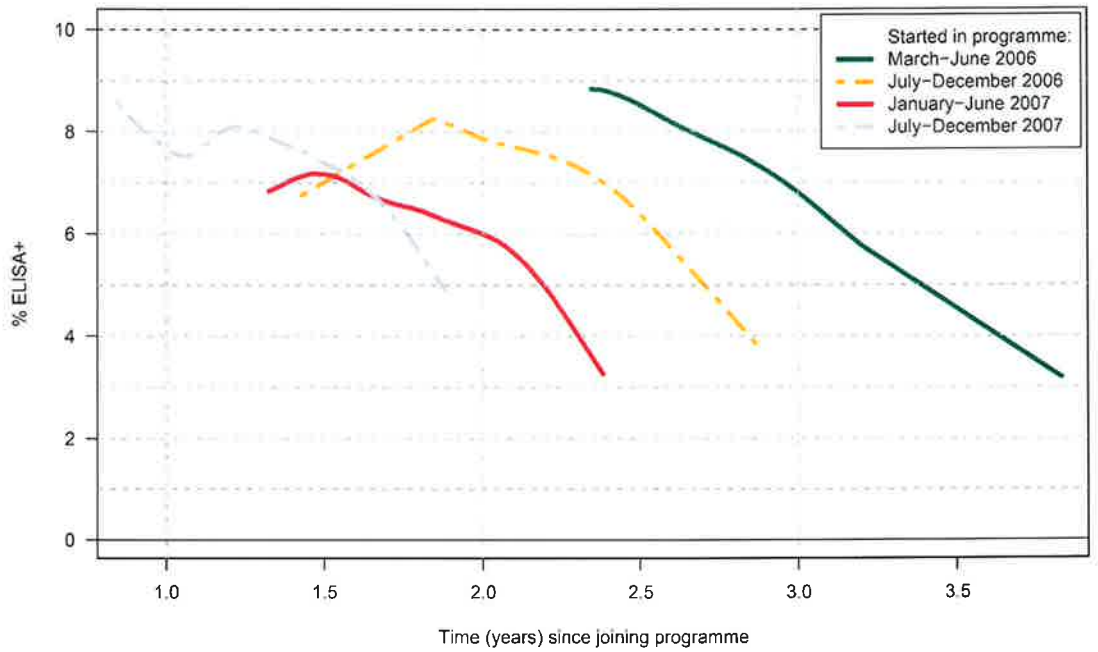

Figure 2. Development in test prevalence in 4 cohorts of herds.

One way of monitoring the overall prevalence is through the test prevalence, if the test is the same over time. In Denmark, the previous ELISA test was replaced in October 15, 2008. Therefore, the test prevalences before and after this date are difficult to compare. Results primarily based on the new test are shown for 4 different cohorts in Fig. 2. The data suggests that there is a significant reduction in the test prevalence in all 4 cohorts, but the prevalence in herds that have been in the programme longer has dropped slightly more. However, these herds also had a higher prevalence in the first place. These falls in prevalence cannot be achieved only through

changes in management aimed at reducing transmission because such an effect would only be expected to occur after a minimum of 2-3 years. Thus, culling of test-positive animals is also likely to influence the numbers. Furthermore, there may be a seasonal effect that is not yet evident in the graphs shown here. It will be important to monitor the test prevalence continuously to determine if there actually is a reduction in the overall prevalence.

II. Implementation of changes in management to reduce transmission of MAP

Multiple simulation studies have suggested that changes in management to reduce transmission are cornerstones for successful control of MAP, whereas test-and-cull regimens alone will not lead to eradication. Accordingly, farmers in the programme should adhere to the recommendations on MAP transmission management. Recommendations for within-herd reduction of MAP transmission primarily focus on management around calving and use of waste milk and colostrum for calves. Table 2 contains data, which show the apparent ability of farmers to adhere to the recommendations. It is clear that many of the recommendations are not followed and success can therefore not be expected in many farms.

Table 2: Danish farmers' ability to implement 5 major recommendations for reduction of within-herd transmission of MAP. Based on data from 1113 questionnaires sent to the 1265 participants in the Danish control programme in December 2008

Management routine	No.	Percent	Recommendation[b]
1. Calvings of Red[a] and Yellow[a] cows separated from calvings of Green cows			
a) No Red calvings; Green separated from Yellow cows	54	5%	R
b) Green[a] separated from Red and Yellow	275	25%	R
c) Green separated from Red, not Yellow	285	26%	(R)
d) Green, Yellow and Red not separated at calving	499	45%	N
2. Removal of calves from high-risk dams within 2 hours after calving			
a) No Red calvings; Removed from Yellow cows	107	10%	R
b) Removed from Red and Yellow	645	58%	R
c) Removed from Red, not Yellow	192	17%	(R)
d) Not removed	169	15%	N
3. Cleaning of calving facilities after calvings			
a) After Red and Yellow cows' calving	285	26%	R
b) After Red, not after Yellow cows' calving	216	19%	(R)
c) Not cleaned after Red or Yellow cows' calving	612	55%	N
4. Use of colostrum			
a) Only from Green cows, not from Red and Yellow	598	54%	R
b) Used from Yellow, not from Red	282	25%	(R)
c) Used from Red, not from Yellow	112	10%	N
d) Used from Red, Yellow and Green	121	11%	N
5. Use of waste milk and milk from cows with high somatic cell count			
a) Only from Green cows, not from Red and Yellow	745	67%	R
b) Used from Yellow, not from Red	219	20%	(R)
c) Used from Red, Yellow and Green	149	13%	N
Total responders	1113		

[a] Cows are separated into "Red", "Yellow" and "Green" cows based on repeated milk antibody ELISA tests. Red cows have repeated positive results. Green cows repeated negative, and Yellow cows' results fluctuate or have recently become positive. Each herd is tested 4 times per year

[b] R=Follow recommendation by Danish Cattle Federation. (R) = partly follow the recommendation. N = do not follow the recommendation.

If success cannot be expected, the differences in prevalence reduction between herds following recommendations and those that do not should be demonstrated. Given the challenges in monitoring the prevalence and the different management schemes used, it is also difficult to make such comparisons. So far, only univariable analyses have been feasible with the Danish data, and the results may not reflect the effect of a specific management factor. In Figure 3 the effect of removing the newborn calf within 2 hours from High-Risk dams is shown. It is evident that if "Red" (See Table 2.) cows do not calve again, there might be a significant reduction in the test prevalence, but removing the calves from High-Risk animals ("Red" and "Yellow") may also result in a reduction. Doing nothing may increase the prevalence.

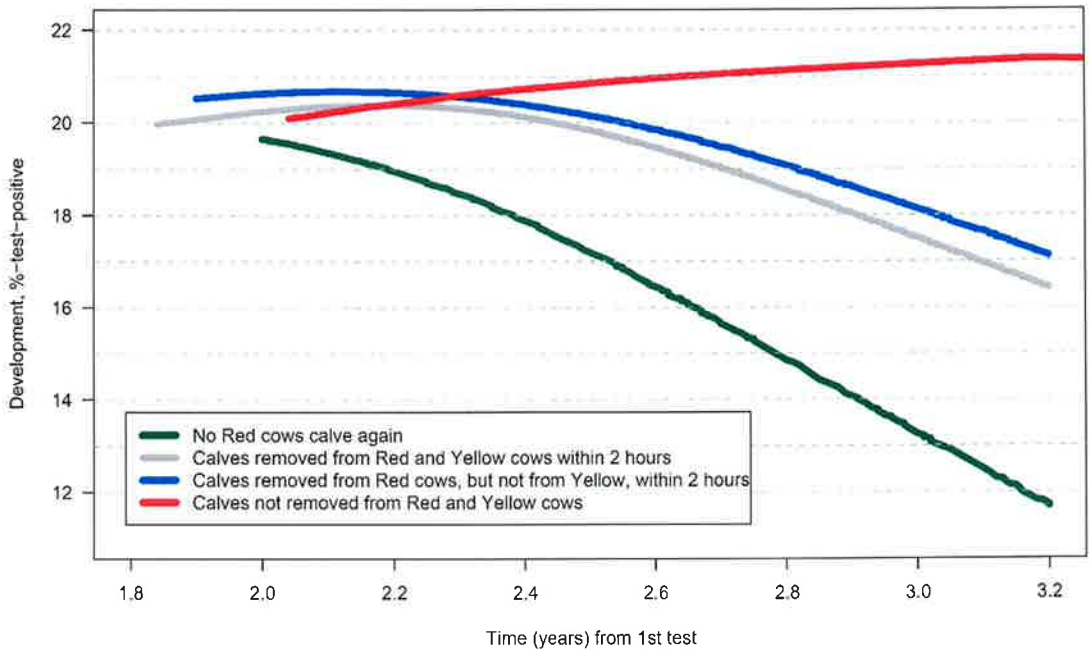

Figure 3. Apparent effect of removing the calf from High-Risk cows within 2 hours after calving.

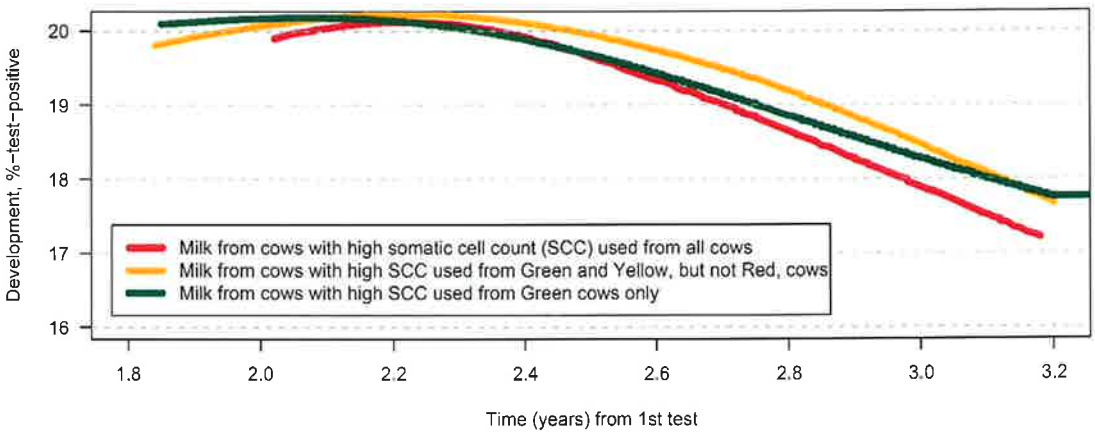

Figure 4. Apparent effect of feeding calves with milk from High-Risk cows with high somatic cell count.

These results are consistent with the expectations of farmers following the recommendations, but it cannot be determined if there are important confounders. Yet, the results can easily be

used to support the recommendations, although they cannot be used to prove them. However, not all results support the recommendations. In Figure 4, there seems to be no difference in the prevalence reduction between the three groups of herds following three different milk feeding regimens. The perceived high-risk behaviour (feeding calves milk containing high levels of high somatic cells from "Red" and "Yellow" cows) does not appear to be a risk factor. All herds have a reduced prevalence, which could be because they take other measures to reduce the prevalence, or an artefact, e.g. seasonal trends in test-prevalences.

Herd level

At herd level, the same considerations apply as at programme level, but it is important that the individual farmer is able to monitor progress, to determine early that she/he is not doing enough to reduce transmission, and to decide whether it is cost-effective to stay in the programme. Accordingly, efforts have been put into

i. educating farmers about the importance of different transmission routes for MAP
ii. educating farmers about interpretation and use of test results for control of MAP
iii. educating farmers about interpretation and use of test results for certification in relation to MAP infections
iv. provision of tools to check if management routines reducing transmission of MAP in the herd have been implemented
v. provision of tools to estimate whether there has been a reduction in the prevalence of MAP overall in the herd and in age-specific groups.
vi. development of a certificate – where "free of MAP infection" can be expressed with greater confidence when increasing levels of information are available for the herd.

There are no systematic tools to monitor if the above mentioned parameters are reached at herd level. The prevalence tools have been developed, but not implemented yet, and the certification programme is also pending.

4.5. Other issues for future consideration

MAP infections in non-dairy herds, other farmed ruminants, and in free-ranging animals have not yet been considered in the programme. The prevalence in beef cattle appears to be lower than in dairy cattle, although MAP infections do occur among beef cattle. There have been no reports of MAP infections in farmed sheep, goats and other ruminants, but there has not been any systematic testing except from exported animals. Free-ranging animals are likely to have MAP infections, but with a high prevalence among farmed animals, transmission to free-ranging animals is highly likely.

4.6. Discussion

Reduction of the prevalence of MAP infections through active participation is the most important parameter. Furthermore, with increasing number of test data from herds that have been in the programme for 3 to 4 years, it will also be possible to better demonstrate positive and negative effects of following the recommendations. Lastly, it is deemed important that a certification module is established to keep farmers in the programme so that they have a long term goal, and to include farmers who do not consider MAP infections a problem in their herd and therefore do not require a control programme.

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